

CLAIMS

What is claimed is:

1. A shape memory alloy comprising, in combination:

a temperature sensitive alloy characterized by a displacive transformation between a first parent phase and a second product phase, said first parent phase maintaining a deformed shape below the M_s temperature following stress and unloading and transformable to an original shape upon reheating above an A_f temperature;

said alloy further characterized by a coherent, nanodispersion of an additional phase providing a misfit of less than about 2.5% in the lattice structure between the nanodispersion and the parent phase.
2. The alloy of claim 1 wherein the alloy comprises principally nickel and titanium in combination with one or more metals selected from the group consisting of aluminum, hafnium, zirconium, palladium, and platinum.
3. The alloy of claim 1 wherein the alloy comprises titanium, nickel, aluminum and one or more additive materials selected from the group consisting of hafnium, zirconium, palladium, and platinum, said alloy comprising a Heusler phase nanodispersion distributed in a B2 parent phase.
4. The alloy of claim 3 comprising in atomic percent about 32 to 40 percent titanium, 3 to 4 percent aluminum and 8 to 15 percent zirconium, and the balance nickel.

5. The alloy of claim 3 comprising in atomic percent about 32 to 40 percent titanium, 3 to 4 percent aluminum and 9 to 17 percent hafnium, and the balance nickel.

6. The alloy of claim 3 comprising in atomic percent about 47 percent titanium, about 3 percent aluminum, about 5 to 20 percent palladium, and the balance nickel

7. The alloy of claim 3 comprising in atomic percent about 47 percent titanium, about 3 percent aluminum, about 5 to 20 percent platinum, and the balance nickel.

8. The alloy of claim 3 having a T_0 temperature in the range of about -40°C to about 100°C .

9. The alloy of claim 8 having a T_0 temperature of less than about 35°C .

10. The alloy of claim 1 wherein the alloy is comprised of at least about 40 atomic % nickel and about 40 atomic % titanium in combination with less than about 5 atomic % aluminum and less than about 15 atomic % zirconium, said alloy characterized by shape memory transformation at a temperature in the range of about -40°C to 100°C .

11. The shape memory alloy of claim 1 comprising in combination in atomic percent:
about 32 to 47 percent titanium;
about 3 to 4 percent aluminum;

one or more materials in the form of a coherent, nanodispersed phase taken from the group consisting of about 8 to 15 percent zirconium, 5 to 20 percent palladium, 5 to 20 percent platinum, 5 to 20 percent hafnium and mixtures thereof; and the balance nickel.

12. The alloy of claim 11 further including one or more additive materials in atomic percent selected from the group consisting of:

less than 1% boron, less than 9% niobium; and

less than about 500 ppm oxygen and less than about 500 ppm carbon.

13. The alloy of claim 11 comprising in atomic percent about 47 percent titanium, about 3 percent aluminum, about 5 to 20 percent palladium, and the balance nickel.

14. The alloy of claim 11 comprising in atomic percent about 47 percent titanium, about 3 percent aluminum, about 5 to 20 percent platinum, and the balance nickel.

15. The alloy of claim 11 comprising in atomic percent about 32 to 40 percent titanium, about 3 to 4 percent aluminum and about 8 to 15 percent zirconium.

16. The alloy of claim 1 further including an additional, multi-component buffer phase.

17. The alloy of claim 3 further including an additional, multi-component bcc β Nb-Ti phase as a buffer for excess titanium.

18. A method for manufacture of a low misfit, coherent, nanodispersion strengthened shape memory alloy comprising the steps of:

combining by a melting technique the combination in atomic % of at least about 32 to 47 percent titanium, 3 to 4 percent aluminum, 8 to 15 percent zirconium and the balance nickel; and

heat treating said alloy by homogenizing at a temperature less than 1090°C.

19. The method of claim 18 including the further step of aging and then working said alloy to form a part.

20. The method of claim 19 including the further step of solution heat treatment of said alloy.

21. The method of claim 20 comprising the step of solution heat treatment followed by aging to attain peak hardening.

22. The method of claim 20 comprising the step of solution heat treatment at a temperature greater than about 900°C.

23. The method of claim 21 wherein said aging is at a temperature at about 600°C to 800°C.

24. The method of claim 18 comprising a pretreatment and a final treatment, where the pretreatment comprises the steps of solution heat treatment followed by aging to enhance workability, and the final treatment comprises the steps of solution heat treatment followed by aging to attain peak hardening.

25. The method of claim 24 comprising the step of solution treatment in the pretreatment at a temperature greater than about 900°C.

26. The method of claim 24 wherein said aging in the pretreatment is at a temperature of about 600°C to 800°C.

27. The method of claim 24 wherein said solution treatment in the final treatment is at a temperature greater than 900°C.

28. The method of claim 24 wherein said aging in the final treatment is at a temperature at about 600°C to 650°C.

29. A shape memory alloy comprising in combination in atomic percent:
about 30 to 40 percent titanium;
about 3 to 4 percent aluminum;

one or more materials in the form of a coherent nanodispersed phase taken from the group consisting of about 8 to 15 percent zirconium, 9 to 17 percent hafnium and mixtures thereof, where the sum of titanium, aluminum, hafnium and zirconium is about 50 atomic percent; and

the balance nickel.

30. A shape memory alloy comprising in combination in atomic percent:

about 47 percent titanium;

about 3 percent aluminum; and

one or more materials in the form of a coherent nanodispersed phase taken from the group consisting of about 5 to 20 percent palladium, 5 to 20 percent platinum and mixtures thereof, and the balance nickel; where the sum of nickel, palladium, and platinum is about 50 atomic percent.

31. The alloy of claim 1 comprising a CuZnAl combination having a β parent phase and a nanodispersion selected from the group consisting of α or δ phase.

32. The alloy of claim 1 comprising a CuAlNi combination and a δ_2 intermetallic nanodispersion.

33. The alloy of claim 1 comprising a FeMnSi combination and a NbC nanodispersion.